

Distributed Machine Learning-based Digital twins modelling

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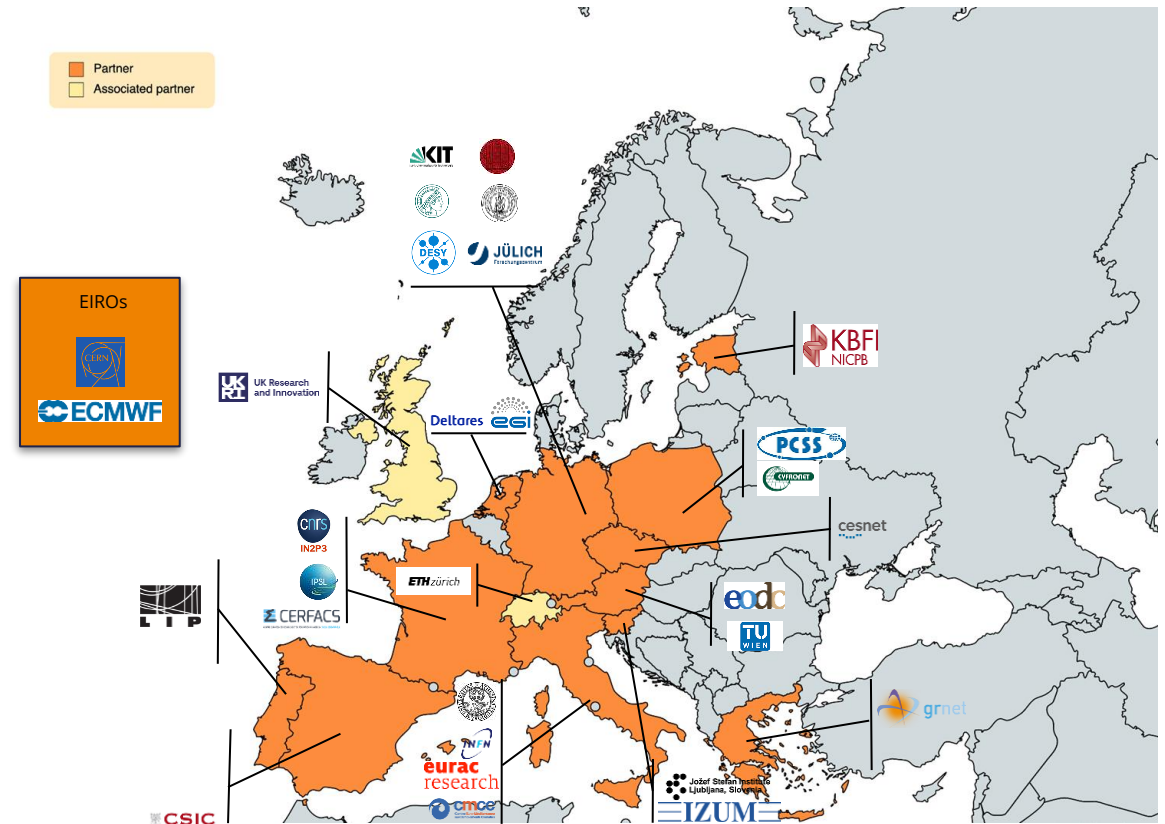
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Intertwin Project

- **Intertwin** is a collaborative project aimed at building a prototype of an **Interdisciplinary Digital Twin Engine (DTE)**.
- The DTE is characterized by being:
 - Modular
 - Open source
 - Interdisciplinary
 - Open standards
 - Unified platform
- Main contribution is to **itwinai** python library

Intertwin collaborators



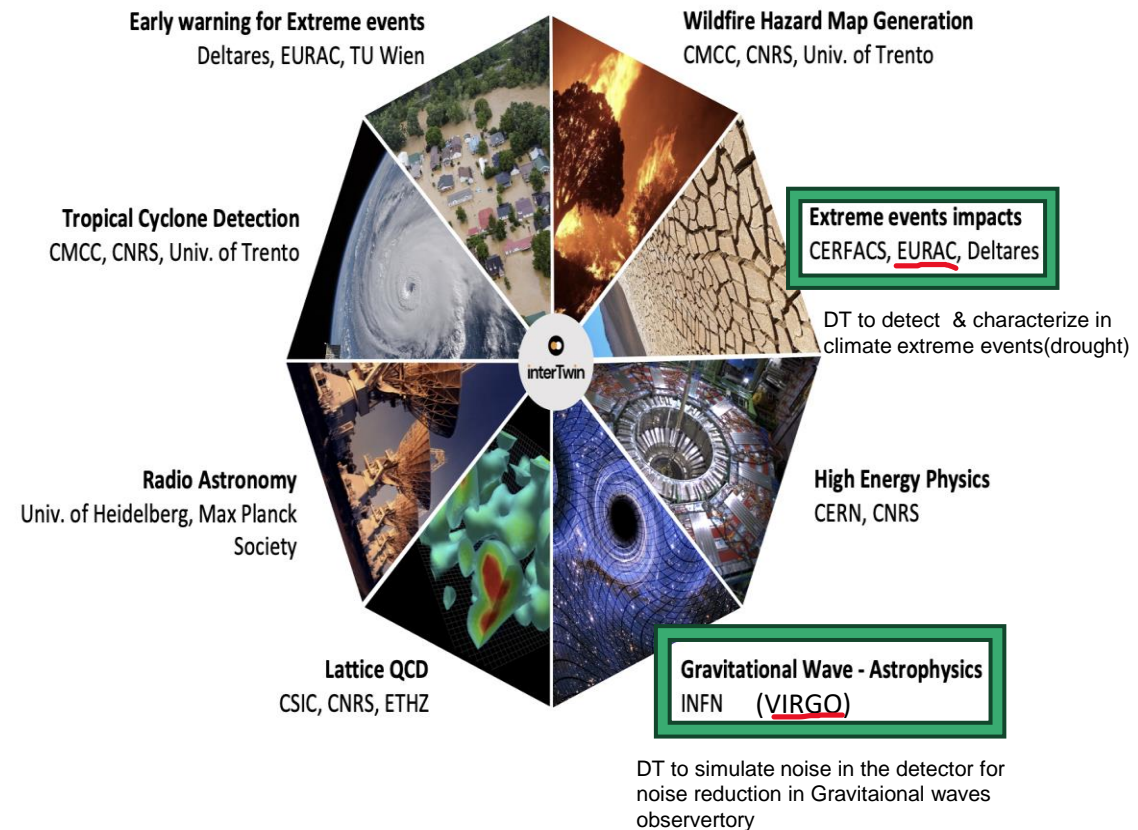
Digital Twins

- A **Digital twin(DT)** is a virtual representation of a physical object, system or process.
- DTs mirror the behavior, performance and characteristics of their physical counterparts.



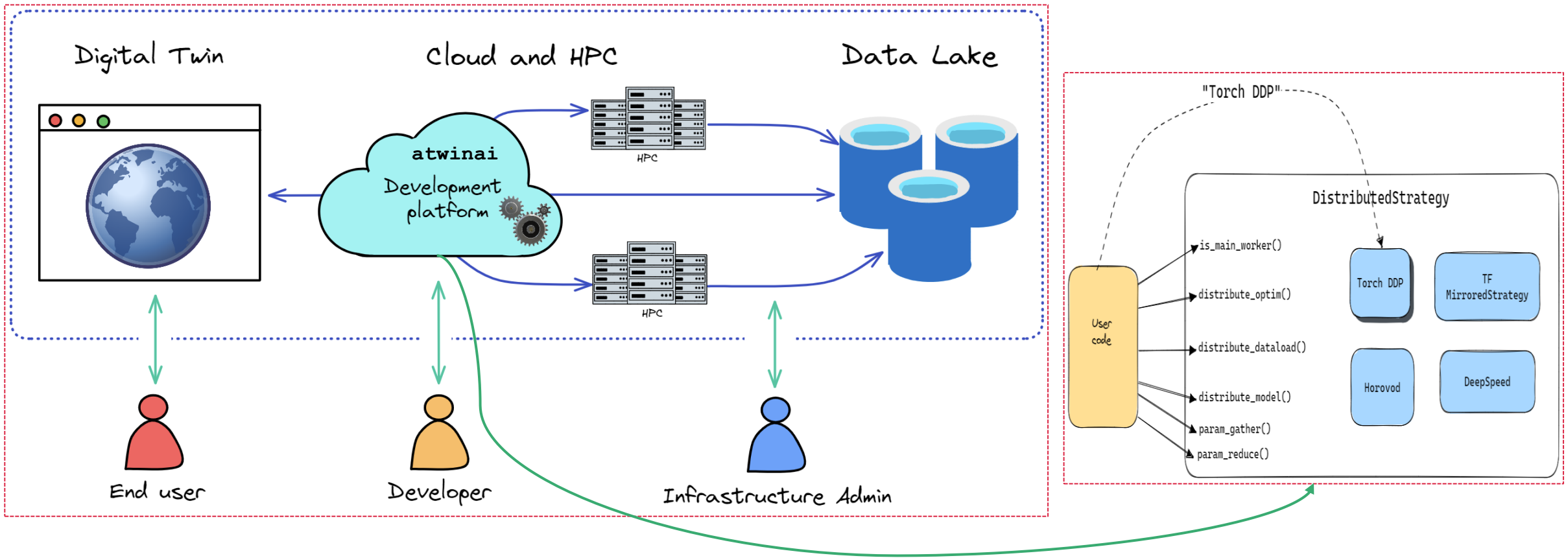
- DTs enable researchers study a physical system in a controlled environment and simulate its behavior in many different scenarios

DT usecases by intertwin



<https://www.intertwin.eu/use-cases/>

Itwinai Architecture

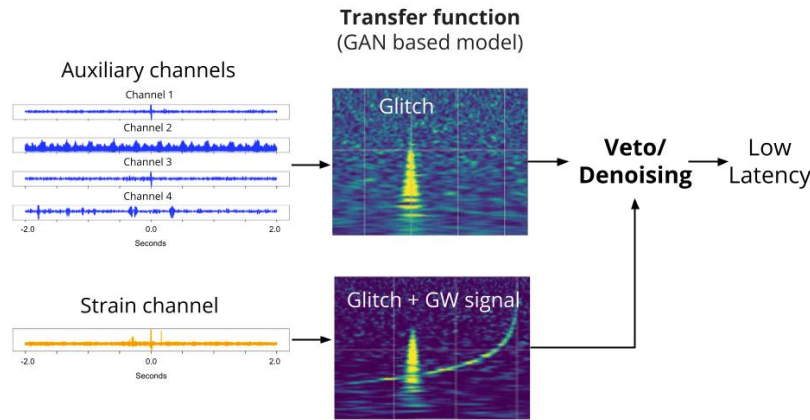


Project Contributions

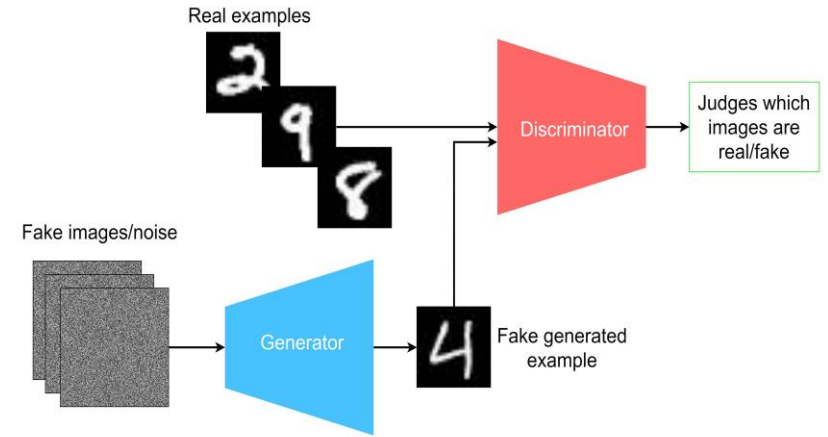
INTEGRATION OF 3 USE CASES & DOCUMENTATION

1. GAN model integration
 - Update trainer to take 2 models
 - Documentation
2. Eurac use case integration
 - Implement gather metrics
 - Add metrics logging
3. Virgo use case integration
 - Generated large dataset
 - Add custom data loader
4. Scaling tests

Virgo arch.



GAN arch.



Eurac arch.

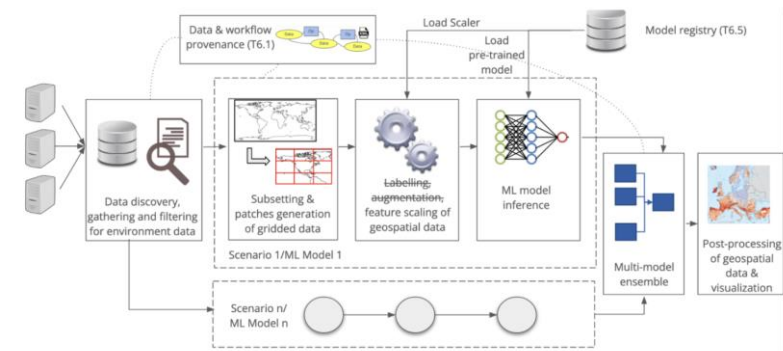


Figure 1 - Overview of the workflow for DT on extreme events

Results 1/3

Distributed Eurac Use case >

agreeable-shad-192

Overview Model metrics System metrics Artifacts

Created at	2024-07-24 19:23:31
Created by	mutegeki1
Experiment ID	521835104429072178 🔗
Status	🟢 Finished
Run ID	f17a53994d7c4a8d818a33c4d70c253c 🔗
Duration	22.4min
Datasets used	—
Tags	Add
Source	🔗 torch_dist_final.py
Logged models	—
Registered models	—

Parameters (25)

🔍 Search parameters

Parameter	Value
target_names	['vwc', 'actevap']
distributed_strategy	TorchDDPStrategy
experiment	test
epochs	10
optim_momentum	0.9
dp_weights	/p/scratch/intertwin/datasets/eurac/model/test.pt
shuffle_test	False
lr	0.0001
seq_length	60
test_temporal_range	slice('2019-01-01', '2020-12-31', None)
batch_size	256
num_workers_data_loader	4
temporal_subsampling	True
train_temporal_range	slice('2016-01-01', '2018-12-31', None)
optim_lr	0.001
shuffle_validation	False
loss	cross_entropy
optimizer	adam

Metrics (6)

🔍 Search metrics

Metric	Value
val_vwc_epoch	0.24340906739234924
val_actevap_epoch	0.10715409368276596
val_loss_per_epoch	0.1906549632549286
train_loss_per_epoch	0.16283413767814636
train_actevap_epoch	0.10892456769943237
train_vwc_epoch	0.2086082398891449

Results 2/3

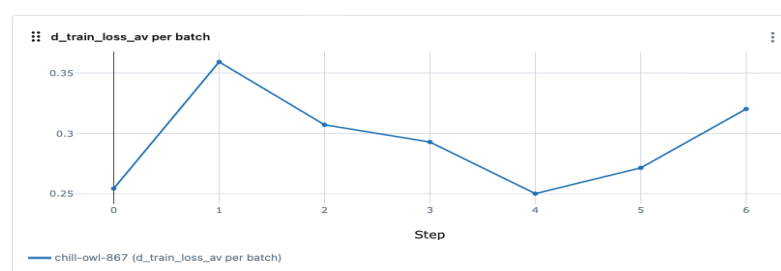
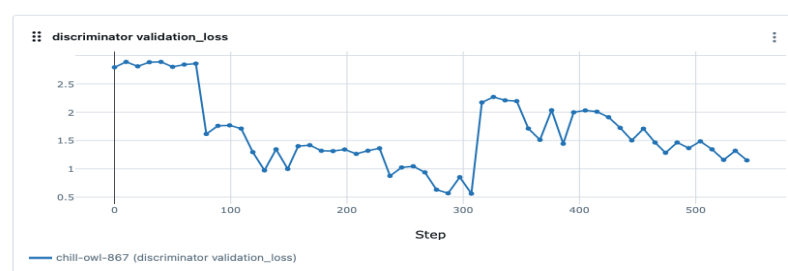
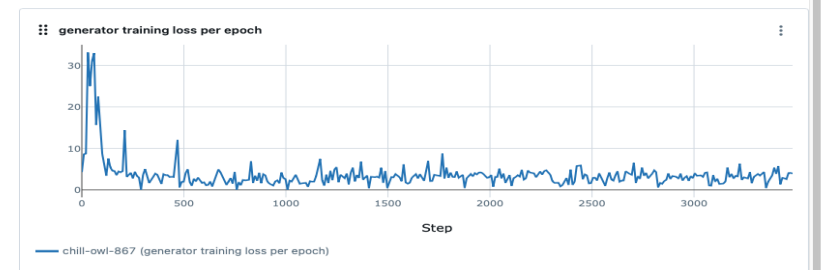
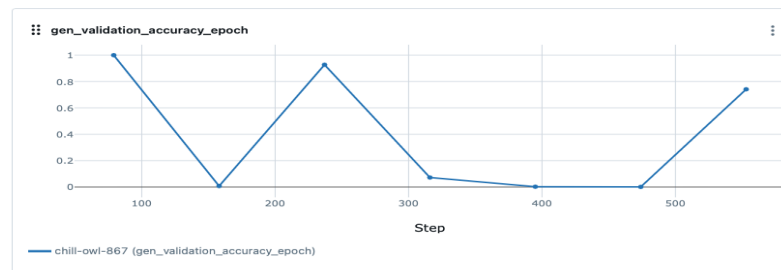
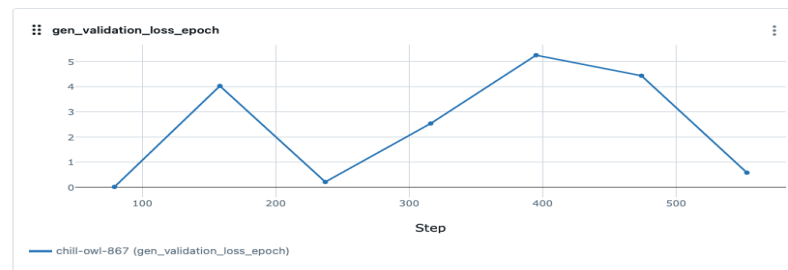
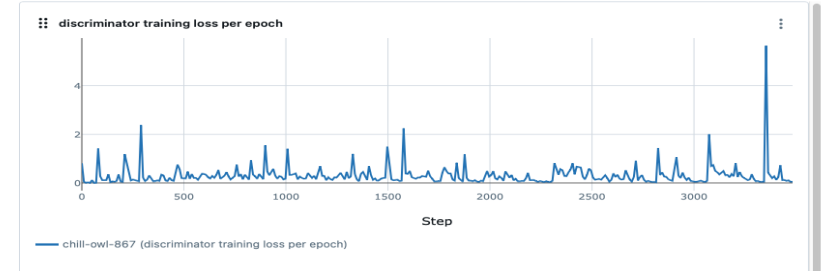
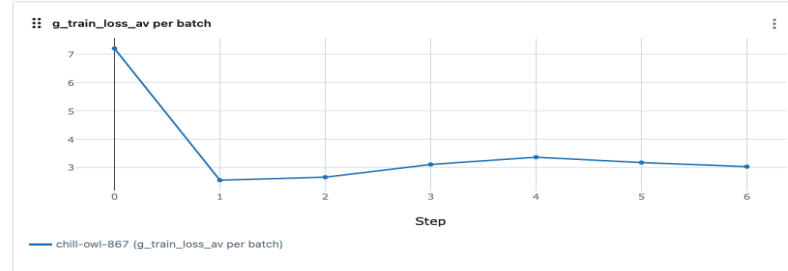
Distributed GAN MNIST >

chill-owl-867

Overview **Model metrics** System metrics Artifacts

Search metric charts

Refresh



Results 3/3

Used slurm arrays to generate large virgo dataset

```
OUTPUT  TERMINAL  PORTS  1  EXPOSED PORTS  GITLENS  DEBUG CONSOLE  PROBLEMS  27  bash - datasets + v [ ] [ ] ...
• (envAI_hdfml) [mutegeki1@hdfml01 datasets]$ du -sh virgo/
46G  virgo/
• (envAI_hdfml) [mutegeki1@hdfml01 datasets]$ ls virgo/
folder_1  folder_109  folder_119  folder_129  folder_139  folder_149  folder_159  folder_169  folder_179  folder_189  folder_199  folder_208  folder_218  folder_228  folder_238  folder_248  folder_32  folder_42  folder_52  folder_62  folder_72  folder_82  folder_92
folder_10  folder_11  folder_12  folder_13  folder_14  folder_15  folder_16  folder_17  folder_18  folder_19  folder_2  folder_209  folder_219  folder_229  folder_239  folder_249  folder_33  folder_43  folder_53  folder_63  folder_73  folder_83  folder_93
folder_100  folder_110  folder_120  folder_130  folder_140  folder_150  folder_160  folder_170  folder_180  folder_190  folder_20  folder_21  folder_22  folder_23  folder_24  folder_25  folder_34  folder_44  folder_54  folder_64  folder_74  folder_84  folder_94
folder_101  folder_111  folder_121  folder_131  folder_141  folder_151  folder_161  folder_171  folder_181  folder_191  folder_200  folder_210  folder_220  folder_230  folder_240  folder_250  folder_35  folder_45  folder_55  folder_65  folder_75  folder_85  folder_95
folder_102  folder_112  folder_122  folder_132  folder_142  folder_152  folder_162  folder_172  folder_182  folder_192  folder_201  folder_211  folder_221  folder_231  folder_241  folder_26  folder_36  folder_46  folder_56  folder_66  folder_76  folder_86  folder_96
folder_103  folder_113  folder_123  folder_133  folder_143  folder_153  folder_163  folder_173  folder_183  folder_193  folder_202  folder_212  folder_222  folder_232  folder_242  folder_27  folder_37  folder_47  folder_57  folder_67  folder_77  folder_87  folder_97
folder_104  folder_114  folder_124  folder_134  folder_144  folder_154  folder_164  folder_174  folder_184  folder_194  folder_203  folder_213  folder_223  folder_233  folder_243  folder_28  folder_38  folder_48  folder_58  folder_68  folder_78  folder_88  folder_98
folder_105  folder_115  folder_125  folder_135  folder_145  folder_155  folder_165  folder_175  folder_185  folder_195  folder_204  folder_214  folder_224  folder_234  folder_244  folder_29  folder_39  folder_49  folder_59  folder_69  folder_79  folder_89  folder_99
folder_106  folder_116  folder_126  folder_136  folder_146  folder_156  folder_166  folder_176  folder_186  folder_196  folder_205  folder_215  folder_225  folder_235  folder_245  folder_3  folder_4  folder_5  folder_6  folder_7  folder_8  folder_9
folder_107  folder_117  folder_127  folder_137  folder_147  folder_157  folder_167  folder_177  folder_187  folder_197  folder_206  folder_216  folder_226  folder_236  folder_246  folder_30  folder_40  folder_50  folder_60  folder_70  folder_80  folder_90
folder_108  folder_118  folder_128  folder_138  folder_148  folder_158  folder_168  folder_178  folder_188  folder_198  folder_207  folder_217  folder_227  folder_237  folder_247  folder_31  folder_41  folder_51  folder_61  folder_71  folder_81  folder_91
```

Thank you!



Questions ?